

APPLICATION OF TIMS DATA IN STRATIGRAPHIC ANALYSIS

H.R. Lang, Jet Propulsion Laboratory, California Institute of Technology*, Pasadena, California 91109.

SUMMARY

An in-progress study demonstrates the utility of TIMS data for unraveling the stratigraphic sequence of a western interior, North American foreland basin. TIMS data can be used to determine the stratigraphic distribution of minerals that are diagnostic of specific depositional environments. TIMS data identify carbonate, gypsum, and quartz-bearing beds in a Permian - Cretaceous sequence. Combined TIMS, and TM results illustrate the feasibility of "spectral stratigraphy", remote lithostratigraphic analysis.

Laboratory transmission spectra reported by Hunt and Salisbury (1975) and Hunt (1980) demonstrated that multispectral thermal data potentially could be used to identify minerals of lithostratigraphic significance (Figure 1). With the availability of TIMS data in 1982, the validity of these laboratory results for geological remote sensing in sedimentary terrane could be tested.

TM and TIMS data were acquired in the Wind River/Bighorn area of central Wyoming in November 1982, and July 1983, respectively. Combined image processing, photogeologic, and spectral analysis methods were used to: 1) map strata, 2) construct stratigraphic columns, 3) correlate strata, and 4) identify mineralogical facies.

Photogeologic interpretation of a 1:250,000 scale TM color composite image identified an appropriate locality for constructing an image-derived stratigraphic column. This "type locality" encompasses exposures of homoclinal strata in the Deadman Butte area of the Casper Arch, eastern Wind River Basin. A 1:24,000 512x512 pixel TM image of the Deadman Butte area provided a photogeologic base for mapping spectral, textural, and geomorphically defined stratigraphic horizons. The TM image geometrically matched USGS 7 1/2' topographic maps. Thus, standard geologic map interpretation methods were used to construct a stratigraphic column incorporating TM spectral characteristics, true stratigraphic thickness and resistance of the photogeologic units. This column was correlated with a conventional surface section measured 10km to the west. Thus, 38 image units were assigned to 11 formations ranging from the Permian Phosphoria to the Cretaceous Cody Shale. The stratigraphic column was also correlated with a similarly constructed column from a structurally complex area in the southern Bighorn Basin and also with well logs from both the Wind River and Bighorn Basin.

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TIMS data were registered to the 1:24,000 scale Deadman Butte TM image. Photogeologic interpretation of a band 1 (blue), 3 (green), 5 (red) decorrelation stretch image of the registered TIMS data provided compositional information for TM defined stratigraphic units. Kahle and Rowan (1980) and Gillespie and others (1984) demonstrated the spectral significance of image colors in similarly processed TIMS data. Red colors in the TIMS Deadman Butte image portray the stratigraphic distribution of quartz (sandstones throughout the section); green, carbonate (dolostones in the Phosphoria Formation and limestones in the Alcova and Sundance Formation); and yellow/green, gypsum (evaporites in the Dinwoody/Red Peak Formation transition). This lithostratigraphic information was incorporated into the TM defined stratigraphic column.

Field sampling sites, selected to represent distinct spectral classes, were identified based upon the TIMS interpretation. In July, 1984, these sites were visited and 67 field emission spectra were acquired at 8 field sampling sites with JPL's PFES (see Bartholomew, these proceedings for a description of JPL's field and laboratory thermal spectrometers). Samples were also obtained for laboratory XRD and thermal reflectance analyses. Field and laboratory results confirmed the spectral and compositional interpretation of the TIMS decorrelation stretch image. Four examples of field and laboratory spectral results are illustrated in Figure 2. These results confirm the utility of spectra reported by Hunt and Salisbury (Figure 1) for interpreting TIMS data and support the approach to interpreting colors of band 1,3,5 decorrelation stretch TIMS images cited above. The similarity of field and laboratory spectra illustrated in Figure 2 indicates that laboratory reflectance spectra may be valid surrogates for field spectra in studies of the spectral characteristics of similar rocks in TIMS wavelengths. Additionally these spectra indicate that TIMS ratio images may be useful for mapping sedimentary rocks.

These results demonstrate the feasibility of using coregistered TIMS, TM and topographic data for lithostratigraphic analysis. When available, STIMS data could provide images with sufficient cartographic fidelity to replace TM data as a photogeologic base for similar spectral stratigraphic studies.

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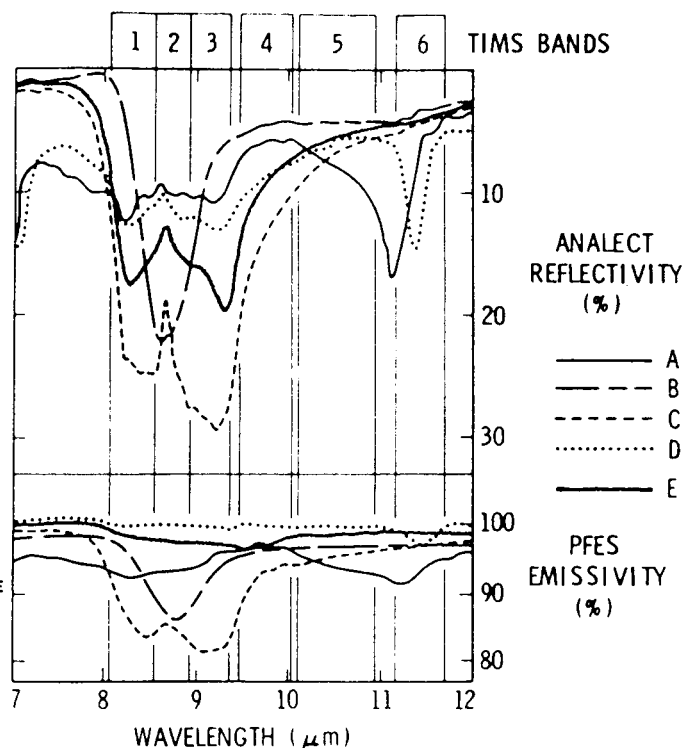
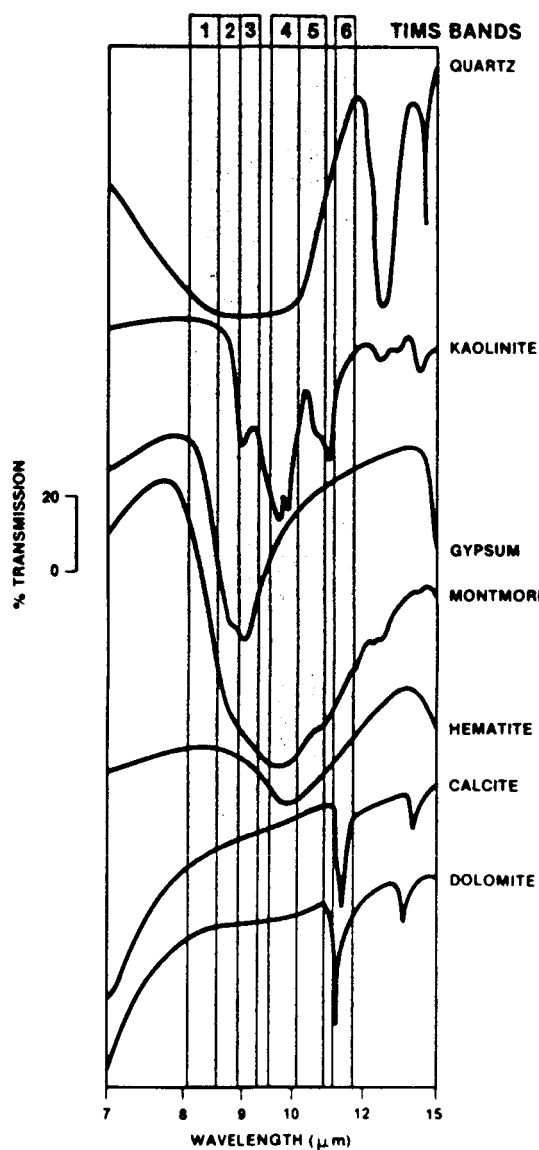


Figure 2. Laboratory reflectivity and field emissivity spectra of the same natural rock surfaces from the Deadman Butte area:

- A - dolostone
- B - bedded gypsum
- C - orthoquartzite
- D - marly limestone
- E - bentonitic shale.

Figure 1. Laboratory transmission spectra of sedimentary rock forming mineral powders (After Hunt and Salisbury, 1975 and Hunt 1980).